

**REMARKS**

Claim 1 has been amended. Upon entry of this amendment, claims 1-42 will be pending in the application.

\* Attached hereto is a marked-up version of the changes made to claim 1 by the current amendment. The attached pages are captioned **"Version With Markings to Show Changes Made"**.

**Amendment to Figure 1**

\* In response to the Examiner's continued objection to Figure 1, a copy of amended Figure 1 which accompanied the Letter to the Official Draftsman filed June 20, 2002 is enclosed.

**Rejection under 35 U.S.C. §103(a)**

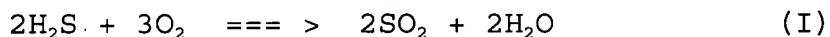
Reconsideration is respectfully requested of the rejection of claims 1-42 under 35 U.S.C. §103(a). The pending claims are submitted as patentable over U.S. Patent No. 4,088,743 (Hass et al.), U.S. Patent No. 5,851,265 (Burmester et al.) and the Gas Purification text by Kohl et al.

**Claim 1**

Independent claim 1 is directed to a process for the production of sulfur from an acid gas feed stream comprising hydrogen sulfide wherein a feed gas mixture comprising at least a portion of the acid gas feed stream and sulfur dioxide is introduced into a single Claus catalytic reaction zone and contacted with a Claus conversion catalyst to react hydrogen sulfide with sulfur dioxide and form a product gas effluent comprising elemental sulfur and water. The product gas effluent is cooled to condense and separate elemental sulfur from the product gas effluent, forming a tail gas effluent. A portion of the tail gas effluent is sent to an incinerator and combusted with a source of oxygen to form a combustion gas effluent comprising sulfur dioxide. The combustion gas effluent comprising sulfur dioxide is subjected to a sulfur dioxide absorption/stripping cycle to produce a sulfur dioxide-enriched stripper gas which is combined with at least a portion of the

acid gas feed stream in the feed gas mixture introduced into the Claus catalytic reaction zone. Accordingly, the process defined in claim 1 is a catalytic only Claus sulfur recovery unit which omits a Claus reaction furnace conventionally employed to combust a portion of the hydrogen sulfide in the incoming acid feed gas to form sulfur dioxide upstream of the Claus catalytic stage. Instead, the sulfur dioxide for the Claus reaction is derived by combusting a portion of the tail gas effluent exiting the sulfur condenser to form a combustion gas effluent and introducing a sulfur dioxide-enriched stripper gas recovered from the combustion gas effluent into the Claus catalytic reaction zone. Moreover, in accordance with the process defined in claim 1, the temperature within the Claus catalytic reaction zone is moderated by including the remainder of the tail gas effluent in the feed gas mixture introduced into the Claus catalytic reaction zone. By proportioning the split of tail gas effluent between the incinerator and the Claus catalytic reaction zone, the temperature within the Claus catalytic reaction zone can be moderated as desired.

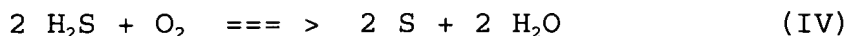
In the primary reference relied on in the Office action, Hass et al. disclose a process for the selective catalytic incineration or oxidation of hydrogen sulfide in a feed gas (e.g., geothermal steam) **with oxygen** in a catalytic incinerator (11) to produce sulfur dioxide according to the following highly exothermic reaction:



The formation of elemental sulfur by the Claus reaction ( $2 \text{H}_2\text{S} + \text{SO}_2 < \text{===} > 3/4 \text{S}_8 + 2 \text{H}_2\text{O}$ ) in the catalytic incinerator (11) and in the gases discharged therefrom is expressly avoided (See col. 3, line 67 to col. 4, line 20).

However, in Example 1, Hass et al. disclose that in instances where the incoming feed gas contains more than about 400 ppmv of  $\text{H}_2\text{S}$ , it may be desirable prior to selective catalytic incineration to catalytically oxidize a portion of the  $\text{H}_2\text{S}$  **with**

**oxygen** directly to elemental sulfur according to the following reaction:



This is achieved by directing all or a portion of the feed gas 1 in Fig. 1 to catalytic oxidation reactor (25) along with an oxygen-containing gas. The "most critical aspect of the invention" as disclosed by Hass et al. resides in the nature of the supported vanadium catalysts employed in the catalytic incinerator (11) and catalytic oxidation reactor (25) which are said to be so selective for the selective **air** oxidation of hydrogen sulfide to sulfur dioxide that highly oxidizable components that might be present in the incoming sour gas (e.g.,  $\text{H}_2$ , CO and light hydrocarbons) remain almost completely unoxidized (See col. 3, lines 13-18; col. 6, lines 24-44; and col. 7, line 30 to col. 9, line 36).

As acknowledged by the Examiner on page 4 of the Office action, Hass et al. fail to teach or suggest requirements of claim 1, including recovering a sulfur dioxide-enriched gas from the tail gas effluent and recycling and introducing the sulfur dioxide-enriched gas as part of a feed gas mixture fed to a Claus catalytic reaction zone wherein the sulfur dioxide serves as the oxidant gas reacted with hydrogen sulfide in the feed gas mixture to form elemental sulfur and water in accordance with the Claus reaction. Instead, Hass et al. teach that the "purified off gases" discharged from the catalytic incinerator (11) in Fig. 2 are discharged to the atmosphere, preferably after being contacted with an aqueous solvent to remove sulfur dioxide in conventional sulfur dioxide scrubber 180 (See col. 16, lines 40-46).

To overcome the admitted deficiencies of the primary reference, the Examiner attempts to rely of the teachings of Burmaster et al. of recovering a sulfur dioxide-enriched gas from the incinerator of a Claus plant and recycling and feeding the

sulfur dioxide-enriched gas to the Claus plant to react with hydrogen sulfide in the incoming feed gas.

In order to establish a *prima facie* case of obviousness, there must be some suggestion or motivation to combine the reference teachings. A teaching, suggestion or motivation to combine reference teachings is an essential element of an obviousness rejection. Moreover, any proposed modification cannot change the principal of operation of a reference. Applicants respectfully submit that the proposed modification of Hass et al. with the teachings of Burmaster et al. fails to establish a *prima facie* case of obviousness.

Starting on page 5 of the Office action, the Examiner states that

"[i]t would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the **Claus process illustrated in Fig. 2" of Hass et al.** "by feeding the sulfur dioxide-containing incinerator off-gas to the sulfur dioxide absorber (11)" of Burmaster et al. "instead of passing this incinerator off-gas through the 'SO2 scrubber' illustrated as feature 180 in Fig. 2" of Hass et al. "because of the expected advantage of recovering sulfur dioxide within the incinerator off-gas in the form of elemental sulfur via treatment in the Claus plant" of Burmaster et al. **"which would be the 'oxidation reactor' 25 illustrated in Fig. 2" of Hass et al.** (emphasis added)

Later on page 6 of the Office action, the Examiner proposes that the modification would include replacing the "air" (20) in Fig. 2 of Hass et al. with the "the sulfur dioxide-containing tail gas (48) illustrated in Fig. 3" of Burmaster et al.<sup>1</sup>

Contrary to the above-quoted assertion in the Office action, Fig. 2 of Hass et al. does not depict a Claus process. Importantly, the catalytic oxidation reactor (25) in Hass et al. is not supplied with a **sulfur dioxide-containing feed gas** mixture for reaction with hydrogen sulfide to produce elemental sulfur

---

<sup>1</sup> Applicants note that reference numeral (48) in Fig. 3 of Burmaster et al. is the tail gas stream exiting the sulfur trioxide absorber of a contact sulfuric acid plant (44). It is assumed that the Examiner intended to refer to the sulfur dioxide-enriched stripper gas stream (31) exiting separator (30).

and water in accordance with the Claus reaction as recited in claim 1. Instead, the catalytic oxidation reactor (25) is fed with **air or other oxygen-containing gas** (See reference numeral (20) in Fig. 2 of Hass et al.) which serves as the oxidant in the selective oxidation of hydrogen sulfide to form sulfur dioxide. While Hass et al. suggest that formation of elemental sulfur in the catalytic oxidation reactor (25) proceeds in part by the Claus reaction, the sulfur dioxide reactant is not present in the gas fed to the reactor, but is generated therein by the selective oxidation of hydrogen sulfide with oxygen in the feed gas (See col. 6, lines 1-2). Nothing in the disclosure of the cited references would motivate one skilled in the art to replace air or other oxygen-containing gas with sulfur dioxide as the oxidant employed in the catalytic oxidation reactor (25). Indeed, the proposed substitution of sulfur dioxide for air as the oxidant in the process disclosed by Hass et al. is contrary to the principal of operation of the primary reference since the supported vanadium catalysts said to be critical to the invention disclosed therein are expressly intended for the selective **air** incineration or oxidation of hydrogen sulfide to sulfur dioxide or sulfur (See, for example, col. 1, lines 55-57).

In view of the forgoing, applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness with respect to claim 1. Accordingly, claim 1 and claims 2-32 dependent therefrom are patentable over the art of record.

As in the previous Office action mailed March 27, 2002, the Examiner has again misconstrued the clear language of claim 1 when on page 6 of the present Office it is stated that the limitation of claim 1 describing the effect that the recycled **sulfur dioxide-containing stripper gas** has on the temperature in the catalytic reactor is obvious. As pointed out by Applicants in their response to the previous Office action, the temperature moderation effect in the Claus catalytic reaction zone is achieved in claim 1 by the requirement of recycling a portion of the **tail gas effluent** exiting the sulfur condenser and

introducing it into the Claus catalytic reaction zone as part of the feed gas mixture. Referring to amended Figure 1 enclosed herewith, the **sulfur dioxide-containing stripper gas** recycled to the Claus catalytic reaction zone is identified by reference numeral 19 and the portion of the **tail gas effluent** introduced into the Claus catalytic reaction zone is identified by reference numeral 39. In any event, although Hass et al. mention recycle of gas exiting the sulfur condenser (27) to the catalytic oxidation reactor (25) for purposes of temperature moderation in the reactor (See col. line 65 to col. 7, line 6), this disclosure does not overcome the shortcomings in the attempted modification of Hass et al. with teachings of Burmaster et al. for the reasons set forth above.

### Claim 33

Independent claim 33 is directed to a process for the production of elemental sulfur from an acid gas feed stream containing hydrogen sulfide and an unsaturated hydrocarbon component selected from the group consisting of linear olefins, branched olefins, aromatic hydrocarbons and mixtures thereof. The hydrogen sulfide is oxidized to elemental sulfur in a catalytic reaction zone containing an oxidation catalyst and supplied with an oxidant gas. The acid gas feed stream is pretreated upstream of the catalytic reaction zone to reduce the concentration of the unsaturated hydrocarbon component and inhibit deactivation of the catalyst by contacting at least a portion of the acid gas feed stream with an aqueous acid wash, thereby forming an addition reaction product which can be separated from the acid gas feed stream.

The Examiner concedes on page 10 of the Office action that Hass et al. neither teaches nor suggests a washing step that results in olefins and/or aromatics being removed from the gas fed to the catalytic oxidation reactor (25), but then attempts to overcome this deficiency by inexplicably asserting that these same olefins and/or aromatics are expected to be **inherently** present in the same gases mentioned in the paragraph bridging

pages 451 and 454 of the Gas Purification text by Kohl et al. and would be removed in an acidic water wash in contact condenser (80) of Hass et al.

Applicants wish to remind the Examiner that the fact that a certain result or characteristic **may** occur or be present in the prior art is not sufficient to establish inherency of that result or characteristic. In re Rijckaert, 28 U.S.P.Q.2d 1955 (Fed. Cir. 1993) (emphasis in original). When relying upon the theory of inherency, the Examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic **necessarily** flows from the teachings of the applied prior art. Ex parte Levy, 17 U.S.P.Q.2d 1461 (Bd. Pat. App. & Inter. 1990) (emphasis in original).

Applicants respectfully submit that nothing in the cited references compels the conclusion that the feed gases disclosed therein necessarily contain an unsaturated hydrocarbon component as recited in claim 33. Quite to the contrary, the primary reference is devoid of any mention of unsaturated hydrocarbons. The Examiner's particular attention is directed to the teaching of Hass et al. at col. 2, lines 31-45 set forth below:

"This invention is particularly concerned with the selective oxidation of  $H_2S$  to  $SO_2$  in a feed gas comprising  $H_2S$  and any of the relatively inert inorganic gases such as nitrogen, carbon dioxide, water vapor, argon, helium, neon, etc., and/or any of the normally oxidizable components such as  $H_2$ , CO and light hydrocarbons. As used herein, the term "light hydrocarbons" refers to those **saturated** hydrocarbons containing no more than six carbon atoms. Many other gases may be present in the feed gas but as those skilled in the art will readily understand, the remaining gaseous components (except for sulfur vapor as will be shown hereinafter) should be chemically inert under the conversion conditions specified herein, **and should not adversely affect or poison the catalyst.**" (emphasis added)

Thus, any contention that the unsaturated hydrocarbon component required in claim 33 would inherently be present in the hydrogen sulfide-containing feed gases of Hass et al. is in direct contrast to the express teaching of the reference.

Similarly, the cited teaching in the Gas Purification text that the hydrogen sulfide-containing gas fed to a Claus unit may be derived from acid gases stripped from alkaline solutions or physical solvents used for the purification of sour gases provides no basis for the conclusion that the acid gases would therefore necessarily contain an unsaturated hydrocarbon component as recited in claim 33.

In view of the fact that the references relied on by the Examiner fail to teach or suggest an acid gas feed stream containing an unsaturated hydrocarbon component, much less that such a potentially harmful component can be effectively removed by an aqueous acid wash pretreatment step upstream of the catalytic reaction zone, applicants respectfully submit that the invention defined in independent claim 33 and dependent claims 34-42 are patentable over the art of record.

Conclusion

In view of the above, it is respectfully submitted that the pending claims are clearly patentable over the art of record.

Favorable reconsideration and allowance of all claims are respectfully solicited.

\* Applicant requests an extension of time to and including December 17, 2002 for filing a response to the present Office action. A check in payment of the applicable extension fee is enclosed.

The Commissioner is requested to charge any fee deficiency or overpayment in connection with this amendment to Deposit Account 19-1345.

Respectfully submitted,



Vincent M. Keil, Reg. No. 36,838  
SENNIGER, POWERS, LEAVITT & ROEDEL  
One Metropolitan Square, 16th Floor  
St. Louis, Missouri 63102  
(314) 231-5400

VMK/ACW

\*Enclosure/Attachment

Express Mail Label No. EL 937976677 US



VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claim 1 has been amended as follows:

1. (twice amended) A process for the production of elemental sulfur from an acid gas feed stream containing hydrogen sulfide, the process comprising the steps of:

introducing a feed gas mixture comprising at least a portion of the acid gas feed stream and sulfur dioxide into a single Claus catalytic reaction zone;

contacting [a] the feed gas mixture [comprising at least a portion of the acid gas feed stream and sulfur dioxide] with a Claus conversion catalyst in [a single] the Claus catalytic reaction zone at a temperature effective for the reaction between hydrogen sulfide and sulfur dioxide to form a product gas effluent comprising elemental sulfur and water;

cooling the product gas effluent to condense and separate elemental sulfur from the product gas effluent and form a tail gas effluent;

combusting a portion of the tail gas effluent with a source of oxygen in a combustion zone to oxidize sulfur species present in the tail gas effluent and form a combustion gas effluent comprising sulfur dioxide;

contacting the combustion gas effluent with a liquid absorbent for sulfur dioxide in a sulfur dioxide absorption zone to selectively transfer sulfur dioxide from the combustion gas effluent to the absorbent and produce an exhaust gas from which sulfur dioxide has been substantially removed and a sulfur dioxide-rich absorbent;

stripping sulfur dioxide from the rich absorbent in a sulfur dioxide stripping zone to produce a lean absorbent and a sulfur dioxide-enriched stripper gas;

recycling the lean absorbent to the sulfur dioxide absorption zone for further selective absorption of sulfur dioxide from the combustion gas effluent; and

mixing the sulfur dioxide-enriched stripper gas with at least a portion of the acid gas feed stream and the remainder of the tail gas effluent to form the feed gas mixture introduced into the Claus catalytic reaction zone, the proportion of the tail gas effluent introduced into the Claus catalytic reaction zone as part of the feed gas mixture being sufficient to moderate the temperature within the Claus catalytic reaction zone.